

Practitioner's Docket No. 656,096

10/089896  
JC02 Rec'd PCT/PTO 05 APR 2002

CHAPTER II

Preliminary Classification:

Proposed Class:

Subclass:

NOTE: "All applicants are requested to include a preliminary classification on newly filed patent applications. The preliminary classification, preferably class and subclass designations, should be identified in the upper right-hand corner of the letter of transmittal accompanying the application papers, for example 'Proposed Class 2, subclass 129.'" M.P.E.P., § 601, 7th ed.

TRANSMITTAL LETTER  
TO THE UNITED STATES ELECTED OFFICE (EO/US)  
(ENTRY INTO U.S. NATIONAL PHASE UNDER CHAPTER II)

INTERNATIONAL APPLICATION NO	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED
PCT/US00/27357	4 Oct. 2000	5 Oct. 1999
TITLE OF INVENTION		
PROCESS FOR MODIFYING COAL SO AS TO REDUCE SULFUR EMISSIONS		
APPLICANT(S)		
SOMERVILLE, Robin B.; FAN, Liang-Tseng		

Box PCT

Assistant Commissioner for Patents  
Washington D.C. 20231  
ATTENTION: EO/US

**CERTIFICATION UNDER 37 C.F.R. §§ 1.8(a) and 1.10\***  
(When using Express Mail, the Express Mail label number is mandatory;  
Express Mail certification is optional.)

I hereby certify that, on the date shown below, this correspondence is being:

MAILING

☒ deposited with the United States Postal Service in an envelope addressed to the Assistant Commissioner for Patents, Washington, D.C. 20231

37 C.F.R. § 1.8(a)

37 C.F.R. § 1.10 \*

☐ with sufficient postage as first class mail.

☒ as "Express Mail Post Office to Addressee"

Mailing Label No. EL801596250US

TRANSMISSION

☐ facsimile transmitted to the Patent and Trademark Office, (703)

Signature

John S. Egbert

Date: 4-5-02

(type or print name of person certifying)

\* Only the date of filing (§ 1.6) will be the date used in a patent term adjustment calculation, although the date on any certificate of mailing or transmission under § 1.8 continues to be taken into account in determining timeliness. See § 1.703(f). Consider "Express Mail Post Office to Addressee" (§ 1.10) or facsimile transmission (§ 1.6(d)) for the reply to be accorded the earliest possible filing date for patent term adjustment calculations.

(Transmittal Letter to the United States Elected Office (EO/US) [13-18]—page 1 of 9)

JC13 Rec'd PCT/PTC 05 APR 2002

**NOTE:** To avoid abandonment of the application, the applicant shall furnish to the USPTO, not later than 20 months from the priority date: (1) a copy of the international application, unless it has been previously communicated by the International Bureau or unless it was originally filed in the USPTO; and (2) the basic national fee (see 37 C.F.R. § 1.492(a)). The 30-month time limit may not be extended. 37 C.F.R. § 1.495.

**WARNING:** Where the items are those which can be submitted to complete the entry of the international application into the national phase are subsequent to 30 months from the priority date the application is still considered to be in the international state and if mailing procedures are utilized to obtain a date the express mail procedure of 37 C.F.R. § 1.10 must be used (since international application papers are not covered by an ordinary certificate of mailing—See 37 C.F.R. § 1.8.

**NOTE:** Documents and fees must be clearly identified as a submission to enter the national state under 35 U.S.C. § 371 otherwise the submission will be considered as being made under 35 U.S.C. § 111. 37 C.F.R. § 1.494(f).

- I. Applicant herewith submits to the United States Elected Office (EO/US) the following items under 35 U.S.C. § 371:
- ☒ This express request to immediately begin national examination procedures (35 U.S.C. § 371(f)).
  - ☒ The U.S. National Fee (35 U.S.C. § 371(c)(1)) and other fees (37 C.F.R. § 1.492) as indicated below:

2. Fees

CLAIMS FEE	(1) FOR	(2) NUMBER FILED	(3) NUMBER EXTRA	(4) RATE	(5) CALCULATIONS	
<input type="checkbox"/> *	TOTAL CLAIMS	19 - 20 =		× \$18.00 =	\$	
	INDEPENDENT CLAIMS	2 - 3 =		× \$80.00 =		
	MULTIPLE DEPENDENT CLAIM(S) (if applicable) + \$270.00					
BASIC FEE**	<input checked="" type="checkbox"/> U.S. PTO WAS INTERNATIONAL PRELIMINARY EXAMINATION AUTHORITY Where an International preliminary examination fee as set forth in § 1.482 has been paid on the international application to the U.S. PTO: <div style="margin-left: 20px;"> <input type="checkbox"/> and the international preliminary examination report states that the criteria of novelty, inventive step (non-obviousness) and industrial activity, as defined in PCT Article 33(1) to (4) have been satisfied for all the claims presented in the application entering the national stage (37 C.F.R. § 1.492(a)(4)) ..... \$100.00  <input checked="" type="checkbox"/> and the above requirements are not met (37 C.F.R. § 1.492(a)(1)) ..... <del>\$800.00</del> </div>				710	
	<input type="checkbox"/> U.S. PTO WAS NOT INTERNATIONAL PRELIMINARY EXAMINATION AUTHORITY Where no international preliminary examination fee as set forth in § 1.482 has been paid to the U.S. PTO, and payment of an international search fee as set forth in § 1.445(a)(2) to the U.S. PTO: <div style="margin-left: 20px;"> <input type="checkbox"/> has been paid (37 C.F.R. § 1.492(a)(2)) ..... \$710.00  <input type="checkbox"/> has not been paid (37 C.F.R. § 1.492(a)(3)) ..... \$1000.00  <input type="checkbox"/> where a search report on the international application has been prepared by the European Patent Office or the Japanese Patent Office (37 C.F.R. § 1.492(a)(5)) ..... \$860.00         </div>					
	Total of above Calculations					= 710
	Reduction by 1/2 for filing by small entity, if applicable. Assertion must be made. (note 37 C.F.R. § 1.27)					- 355
	Subtotal					355
SMALL ENTITY	Total National Fee				\$ 355	
	Fee for recording the enclosed assignment document \$40.00 (37 C.F.R. § 1.21(h)). (See Item 13 below). See attached "ASSIGNMENT COVER SHEET".					
	Total Fees enclosed				\$ 355	
TOTAL						

\*See attached Preliminary Amendment Reducing the Number of Claims.

☐ Attached is a ☐ check ☐ money order in the amount of \$ \_\_\_\_\_

☒ Authorization is hereby made to charge the amount of \$ 355

☐ to Deposit Account No. 08-0879

☒ to Credit card as shown on the attached credit card information authorization form PTO-2038.

**WARNING:** Credit card information should **not** be included on this form as it may become public.

☒ Charge any additional fees required by this paper or credit any overpayment in the manner authorized above.

A duplicate of this paper is attached.

**\*\*WARNING:** "To avoid abandonment of the application the applicant shall furnish to the United States Patent and Trademark Office not later than the expiration of 30 months from the priority date: \* \* \* (2) the basic national fee (see § 1.492(a)). The 30-month time limit may not be extended." 37 C.F.R. § 1.495(b).

**WARNING:** If the translation of the international application and/or the oath or declaration have not been submitted by the applicant within thirty (30) months from the priority date, such requirements may be met within a time period set by the Office. 37 C.F.R. § 1.495(b)(2). The payment of the surcharge set forth in § 1.492(e) is required as a condition for accepting the oath or declaration later than thirty (30) months after the priority date. The payment of the processing fee set forth in § 1.492(f) is required for acceptance of an English translation later than thirty (30) months after the priority date. Failure to comply with these requirements will result in abandonment of the application. The provisions of § 1.136 apply to the period which is set. Notice of Jan. 3, 1993, 1147 O.G. 29 to 40.

☒ **Assertion of Small Entity Status**

☒ **Applicant hereby asserts status as a small entity under 37 C.F.R. § 1.27.**

**NOTE:** 37 C.F.R. § 1.27(c) deals with the assertion of small entity status, whether by a written specific declaration thereof or by payment as a small entity of the basic filing fee or the fee for the entry into the national phase as states:

"(c) Assertion of small entity status. Any party (person, small business concern or nonprofit organization) should make a determination, pursuant to paragraph (f) of this section, of entitlement to be accorded small entity status based on the definitions set forth in paragraph (a) of this section, and must, in order to establish small entity status for the purpose of paying small entity fees, actually make an assertion of entitlement to small entity status, in the manner set forth in paragraphs (c)(1) or (c)(3) of this section, in the application or patent in which such small entity fees are to be paid.

(1) Assertion by writing. Small entity status may be established by a written assertion of entitlement to small entity status. A written assertion must:

(i) Be clearly identifiable;

(ii) Be signed (see paragraph (c)(2) of this section); and

(iii) Convey the concept of entitlement to small entity status, such as by stating that applicant is a small entity, or that small entity status is entitled to be asserted for the application or patent. While no specific words or wording are required to assert small entity status, the intent to assert small entity status must be clearly indicated in order to comply with the assertion requirement.

(2) Parties who can sign and file the written assertion. The written assertion can be signed by:

(i) One of the parties identified in §§ 1.33(b) (e.g., an attorney or agent registered with the Office), §§ 3.73(b) of this chapter notwithstanding, who can also file the written assertion;

(ii) At least one of the individuals identified as an inventor (even though a §§ 1.63 executed oath or declaration has not been submitted), notwithstanding §§ 1.33(b)(4), who can also file the written assertion pursuant to the exception under §§ 1.33(b) of this part; or

(iii) An assignee of an undivided part interest, notwithstanding §§ 1.33(b)(3) and 3.73(b) of this chapter, but the partial assignee cannot file the assertion without resort to a party identified under §§ 1.33(b) of this part.

(3) Assertion by payment of the small entity basic filing or basic national fee. The payment, by any party, of the exact amount of one of the small entity basic filing fees set forth in §§ 1.16(a), (f), (g), (h), or (k), or one of the small entity basic national fees set forth in §§ 1.492(a)(1), (a)(2), (a)(3), (a)(4), or (a)(5), will be treated as a written assertion of entitlement to small entity status even if the type of basic filing or basic national fee is inadvertently selected in error.

(i) If the Office accords small entity status based on payment of a small entity basic filing or basic national fee under paragraph (c)(3) of this section that is not applicable to that application, any balance of the small entity fee that is applicable to that application will be due along with the appropriate surcharge set forth in §§ 1.16(e), or §§ 1.16(f).

(ii) The payment of any small entity fee other than those set forth in paragraph (c)(3) of this section (whether in the exact fee amount or not) will not be treated as a written assertion of entitlement to small entity status and will not be sufficient to establish small entity status in an application or a patent."

3. ☒ A copy of the International application as filed (35 U.S.C. § 371(c)(2)):

NOTE: Section 1.495 (b) was amended to require that the basic national fee and a copy of the international application must be filed with the Office by 30 months from the priority date to avoid abandonment. "The International Bureau normally provides the copy of the international application to the Office in accordance with PCT Article 20. At the same time, the International Bureau notifies applicant of the communication to the Office. In accordance with PCT Rule 47.1, that notice shall be accepted by all designated offices as conclusive evidence that the communication has duly taken place. Thus, if the applicant desires to enter the national stage, the applicant normally need only check to be sure the notice from the International Bureau has been received and then pay the basic national fee by 30 months from the priority date." Notice of Jan. 7, 1993, 1147 O.G. 29 to 40, at 35-36. See item 14c below.

- a. ☒ is transmitted herewith.
- b. ☐ is not required, as the application was filed with the United States Receiving Office.
- c. ☐ has been transmitted
  - i. ☐ by the International Bureau.

Date of mailing of the application (from form PCT/1B/308):

- ii. ☐ by applicant on \_\_\_\_\_. (Date)

4. ☐ A translation of the International application into the English language (35 U.S.C. § 371(c)(2)):

- a. ☐ is transmitted herewith.
- b. ☐ is not required as the application was filed in English.
- c. ☐ was previously transmitted by applicant on \_\_\_\_\_. (Date)
- d. ☐ will follow.

5. ☒ Amendments to the claims of the International application under PCT Article 19 (35 U.S.C. § 371(c)(3)):

NOTE: The Notice of January 7, 1993 points out that 37 C.F.R. § 1.495(a) was amended to clarify the existing and continuing practice that PCT Article 19 amendments must be submitted by 30 months from the priority date and this deadline may not be extended. The Notice further advises that: "The failure to do so will not result in loss of the subject matter of the PCT Article 19 amendments. Applicant may submit that subject matter in a preliminary amendment filed under section 1.121. In many cases, filing an amendment under section 1.121 is preferable since grammatical or idiomatic errors may be corrected." 1147 O.G. 29-40, at 36.

- a. ☐ are transmitted herewith.
- b. ☒ have been transmitted
  - i. ☐ by the International Bureau.  
Date of mailing of the amendment (from form PCT/1B/308):  
\_\_\_\_\_
  - ii. ☐ by applicant on \_\_\_\_\_. (Date)
- c. ☐ have not been transmitted as
  - i. ☐ applicant chose not to make amendments under PCT Article 19.  
Date of mailing of Search Report (from form PCT/ISA/210.):  
\_\_\_\_\_
  - ii. ☐ the time limit for the submission of amendments has not yet expired. The amendments or a statement that amendments have not been made will be transmitted before the expiration of the time limit under PCT Rule 46.1.

6. ☒ A translation of the amendments to the claims under PCT Article 19 (38 U.S.C. § 371(c)(3)):

- a. ☐ is transmitted herewith.
- b. ☒ is not required as the amendments were made in the English language.
- c. ☐ has not been transmitted for reasons indicated at point 5(c) above.

7. ☒ A copy of the international examination report (PCT/IPEA/409)

- ☒ is transmitted herewith.
- ☐ is not required as the application was filed with the United States Receiving Office.

8. ☐ Annex(es) to the international preliminary examination report

- a. ☐ is/are transmitted herewith.
- b. ☐ is/are not required as the application was filed with the United States Receiving Office.

9. ☐ A translation of the annexes to the international preliminary examination report

- a. ☐ is transmitted herewith.
- b. ☐ is not required as the annexes are in the English language.

(Transmittal Letter to the United States Elected Office (EO/US) [13-18]—page 6 of 9)

10. ☒ An oath or declaration of the inventor (35 U.S.C. § 371(c)(4)) complying with 35 U.S.C. § 115
- a. ☐ was previously submitted by applicant on \_\_\_\_\_. (Date)
  - b. ☐ is submitted herewith, and such oath or declaration
    - i. ☐ is attached to the application.
    - ii. ☐ identifies the application and any amendments under PCT Article 19 that were transmitted as stated in points 3(b) or 3(c) and 5(b); and states that they were reviewed by the inventor as required by 37 C.F.R. § 1.70.
  - c. ☒ will follow.

II. Other document(s) or information included:

11. ☒ An International Search Report (PCT/ISA/210) or Declaration under PCT Article 17(2)(a):
- a. ☒ is transmitted herewith.
  - b. ☐ has been transmitted by the International Bureau.  
Date of mailing (from form PCT/IB/308): \_\_\_\_\_
  - c. ☐ is not required, as the application was searched by the United States International Searching Authority.
  - d. ☐ will be transmitted promptly upon request.
  - e. ☐ has been submitted by applicant on \_\_\_\_\_. (Date)

12. ☐ An Information Disclosure Statement under 37 C.F.R. §§ 1.97 and 1.98:

- a. ☐ is transmitted herewith.

Also transmitted herewith is/are:

- ☐ Form PTO-1449 (PTO/SB/08A and 08B).
- ☐ Copies of citations listed.
- b. ☐ will be transmitted within THREE MONTHS of the date of submission of requirements under 35 U.S.C. § 371(c).
- c. ☐ was previously submitted by applicant on \_\_\_\_\_. (Date)

13. ☐ An assignment document is transmitted herewith for recording.

A separate ☐ "COVER SHEET FOR ASSIGNMENT (DOCUMENT) ACCOMPANYING NEW PATENT APPLICATION" or ☐ FORM PTO 1595 is also attached.

\_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

05 APR 2002

14. ☒ Additional documents:
- a. ☐ Copy of request (PCT/RO/101)
  - b. ☒ International Publication No. WO 01/25373
    - i. ☐ Specification, claims and drawing
    - ii. ☒ Front page only
  - c. ☐ Preliminary amendment (37 C.F.R. § 1.121)
  - d. ☒ Other  
Application Data Sheet
- 
- 
15. ☒ The above checked items are being transmitted
- a. ☒ before 30 months from any claimed priority date.
  - b. ☐ after 30 months.
16. ☐ Certain requirements under 35 U.S.C. § 371 were previously submitted by the applicant on \_\_\_\_\_, namely:
- 
- 
- 
- 

#### AUTHORIZATION TO CHARGE ADDITIONAL FEES

**WARNING:** Accurately count claims, especially multiple dependant claims, to avoid unexpected high charges if extra claims are authorized.

**NOTE:** "A written request may be submitted in an application that is an authorization to treat any concurrent or future reply, requiring a petition for an extension of time under this paragraph for its timely submission, as incorporating a petition for extension of time for the appropriate length of time. An authorization to charge all required fees, fees under § 1.17, or all required extension of time fees will be treated as a constructive petition for an extension of time in any concurrent or future reply requiring a petition for an extension of time under this paragraph for its timely submission. Submission of the fee set forth in § 1.17(a) will also be treated as a constructive petition for an extension of time in any concurrent reply requiring a petition for an extension of time under this paragraph for its timely submission." 37 C.F.R. § 1.136(a)(3).

**NOTE:** "Amounts of twenty-five dollars or less will not be returned unless specifically requested within a reasonable time, nor will the payer be notified of such amounts; amounts over twenty-five dollars may be returned by check or, if requested, by credit to a deposit account." 37 C.F.R. § 1.26(a).

- ☒ Please charge, in the manner authorized above, the following additional fees that may be required by this paper and during the entire pendency of this application:
- ☒ 37 C.F.R. § 1.492(a)(1), (2), (3), and (4) (filing fees)

**WARNING:** Because failure to pay the national fee within 30 months without extension (37 C.F.R. § 1.495(b)(2)) results in abandonment of the application, it would be best to always check the above box.



☐ 37 C.F.R. § 1.492(b), (c) and (d) (presentation of extra claims)

NOTE: Because additional fees for excess or multiple dependent claims not paid on filing or on later presentation must only be paid or these claims cancelled by amendment prior to the expiration of the time period set for response by the PTO in any notice of fee deficiency (37 C.F.R. § 1.492(d)), it might be best not to authorize the PTO to charge additional claim fees, except possible when dealing with amendments after final action.

☐ 37 C.F.R. § 1.17 (application processing fees)

☐ 37 C.F.R. § 1.17(a)(1)–(5) (extension fees pursuant to § 1.136(a).

☐ 37 C.F.R. § 1.18 (issue fee at or before mailing of Notice of Allowance, pursuant to 37 C.F.R. § 1.311(b))

NOTE: Where an authorization to charge the issue fee to a deposit account has been filed before the mailing of a Notice of Allowance, the issue fee will be automatically charged to the deposit account at the time of mailing the notice of allowance. 37 C.F.R. § 1.311(b).

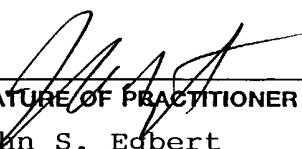
NOTE: 37 C.F.R. § 1.28(b) requires "Notification of any change in loss of entitlement to small entity status must be filed in the application . . . prior to paying, or at the time of paying . . . issue fee." From the wording of 37 C.F.R. § 1.28(b): (a) notification of change of status must be made even if the fee is paid as "other than a small entity" and (b) no notification is required if the change is to another small entity.

☒ 37 C.F.R. § 1.492(e) and (f) (surcharge fees for filing the declaration and/or filing an English translation of an International Application later than 30 months after the priority date).

Reg. No.: 30,627

Tel. No.: (713) 224-8080

Customer No.: 24106

  
SIGNATURE OF PRACTITIONER

John S. Egbert

(type or print name of practitioner)

Harrison & Egbert

412 Main St., 7th Floor

P.O. Address

Houston, Texas 77002

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SULFUR EMISSIONS

Docket No.: 656,096

Suggested Classification

Class:

SubClass:

Tech Center to which subject matter is assigned:

Total Number of Drawings Sheets: 1

Type of Application:

X Utility

\_\_\_ application to be published

suggested drawing figure for publication: \_\_\_

\_\_\_ application is not to be published.

\_\_\_ Plant

Latin name of the genus:

Latin name of the species:

of the plant being claimed.

\_\_\_ Design

\_\_\_ Reissue

\_\_\_ Provisional

Secrecy order under § 5.2:

This application

X does not disclose

\_\_\_ discloses a significant part of the  
subject matter of an application which is under a secrecy order  
pursuant to § 5.2.

4. Representative Information

The following have a power of attorney or authorization of agent in this application:

Name: John S. Egbert, Reg. No. 30,627  
Andrew W. Chu, Reg. No. 46,625  
Al Harrison, Reg. No. 31,708

Address: Harrison & Egbert, 412 Main Street, 7<sup>th</sup> Floor, Houston, Texas 77002 USA

Customer No.: 24106

5. Domestic Priority Information

Domestic priority for this application is claimed as follows:

35 U.S.C. §365(c) [national stage priority]

Appn No.: PCT/US00/27357

Filed: 04 October 2000

Status: entering Chapter II of the PCT

Relationship: national stage priority

Published as WO 01/25373

35 U.S.C. §119(e) [provisional priority]

Appn No.: 60/157,657

Filed: 5 October 1999

Status: provisional

Relationship: parent application of PCT application

6. Foreign Priority Information

Foreign priority is claimed for this application as follows:

Not Applicable.

7. Assignee information

The Assignee of this application is:

Not Applicable.

Respectfully submitted,

Date

4.5.02

Customer No. 24106

John S. Egbert

Reg. No. 30,627

Attorney for Applicant

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## PROCESS FOR MODIFYING COAL SO AS TO REDUCE SULFUR EMISSIONS

TECHNICAL FIELD

The present invention relates to coal desulfurization. More particularly, the present invention relates to methods and processes by which the resultant emissions of sulfur from coal burning operations are reduced. The present invention also relates to the manufacture of coal treated with fresh hydrated lime.

BACKGROUND ART

Electric-power plants fired by coal or oil emit sulfur oxides, nitrogen oxides, and particulates. In industrialized countries, such plants account for up to 75% of the total of sulfur oxides, and, since the electric-power industry is rapidly proliferating, the potential increase of sulfur-oxide emissions is tremendous.

A number of measures have been adopted in an effort to control sulfur-oxide pollution. However, a number of technical problems stand in the way. In many existing power plants, low-sulfur coal cannot be burned without operational difficulties or without incurring high capital costs for furnace modifications. Sulfur can be removed from coal before burning, but the procedure is costly. The content can be cut in half by pulverizing the coal to the consistency of talcum powder and removing the pyrites (sulfur compounds) or by one-third by washing the coal and removing noncarbonaceous material. However, even with as much as 70% of the sulfur removed, the final coal product might still be classified as a high-sulfur fuel.

Several methods of removing sulfur from stack gases have been considered and utilized. In one technique, pulverized limestone or dolomite is added to the boiler charge, creating oxides that react with the sulfur oxides to form solid sulfite and sulfate particles that can be removed by electrostatic precipitation. In another process, catalytic conversion, the sulfur dioxide is converted to sulfur trioxide, which combines with water in the stack gas to form a sulfuric acid mist that can be trapped and eliminated. Another method is to produce sulfuric acid, which can be readily removed from the stack gas by the addition of an activated char, a carbonaceous material.

In most uses, the sulfur content of coal is objectionable in varying degrees. Part of the sulfur is associated with ash, and coal washing removes some sulfur along with the ash. Much sulfur, however, is more intimately associated with the coal substance itself and cannot be removed by washing. Since carbonization removes some sulfur, coke usually contains a lower percentage of sulfur than the coal from which it is made. During total gasification, most of the sulfur is converted into hydrogen sulfide, the form in which it can be readily separated from the gas. Extraction of coal

with solvents produces an extract of relatively low sulfur content. Despite the use of these methods and considerable effort, no effective method has been devised to reduce the sulfur content substantially, particularly the portion closely associated with the coal substance.

It is an object of the present invention to reduce sulfur emissions from the combustion of high-sulfur coal.

It is a further object of the present invention to provide a process that reduces the ash from the combusted coal.

It is a further object of the present invention to provide a process that lowers the pH of the ash of the combusted coal.

It is still a further object of the present invention to provide a process for reducing sulfur emissions in an economic, efficient and easy-to-use operation.

These and other objects and advantages of the present invention will become apparent from a reading of the attached specification.

#### SUMMARY OF THE INVENTION

The present invention is a process for manufacturing modified coal so as to reduce sulfur emissions. This process comprises the steps of: (1) grinding the coal to a powder of a desired consistency and particle size; (2) blending the ground coal with fresh hydrated lime  $[\text{Ca}(\text{OH})_2]$ ; (3) adding water to the blended coal/hydrated lime mixture so as to maintain a moisture content of between 10 and 30% of the overall weight; and (4) drying the agglomerated coal/hydrated lime mixture so as to have a moisture content of a desired level.

In the process of the present invention, the coal is ground to a size of between 80 and 20 meshes (180 micrometers to 850 micrometers). Ideally, the average size of the ground coal particle will be 40 meshes (425 micrometers). Within the concept of the present invention, the coal which is ground is a high-sulfur coal. The fresh hydrated lime is in a powder form. Ideally, the particles of the powder form of the hydrated lime should be less than 10% of the size of the coal particles. The amount of hydrated lime which is added to the ground coal particles will depend upon the sulfur content of the coal. Generally, the amount of fresh hydrated lime will be 1 to 15% of the weight of the coal.

Water is added to the blended mixture of the hydrated lime and ground coal so as to achieve an intimate agglomeration. Finally, the agglomeration is dried so that the moisture content is approximately 1%. The drying can be accomplished by using externally heated dryers or ovens.

The mixture of the water, hydrated lime, and ground coal is heated to a temperature of between 300 and 400°F. The heat for such dryers can be provided by the waste heat of a power plant. The heat can also be provided by a preheater prior to passing the treated coal to the boiler.

#### BRIEF DESCRIPTION OF THE DRAWINGS

FIGURE 1 is a schematic illustration of the process of the present invention.

#### DETAILED DESCRIPTION OF THE INVENTION

Referring to FIGURE 1, there is shown at 10 a schematic representation of the process of the present invention. In the present invention, a coal supply 12 is available for the delivery of coal to a grinder 14. The coal supply 12 can be of a high-sulfur coal. The grinder receives the high-sulfur coal from coal supply 12 and serves to grind the coal so as to reduce the size of the coal particles to an average sieve size in the range of between 20 meshes ( $850 \times 10^{-6}\text{m}$  or 850  $\mu\text{m}$ ) and 80 meshes ( $180 \times 10^{-6}\text{m}$  or 180  $\mu\text{m}$ ). The preferred size of the coal particles will be an average of 40 meshes ( $425 \times 10^{-6}\text{m}$  or 425  $\mu\text{m}$ ).

Initially, a supply 16 of fresh hydrated lime [ $\text{Ca}(\text{OH})_2$ ] is provided in powder form. The actual powder form of the fresh hydrated lime in the supply 16 is of a size which is less than 10% of the size of the coal particles from the grinder 14. The fresh hydrated lime will pass to a blender 18 along with the coal particles from the grinder 14. The fine particles of coal from the grinder 14 are thoroughly blended with a predetermined amount of the fresh hydrated lime. The amount of the hydrated lime [ $\text{Ca}(\text{OH})_2$ ] to be added to the ground coal will depend upon the content, nature and distribution of sulfur in the coal. The amount of hydrated lime should range from between 1 to 15% of the weight of the coal. The preferred amount of hydrated lime which is added to the ground coal will be approximately 5% to 6% when the sulfur content of the coal is about 3%.

As can be seen in FIGURE 1, inlet 20 is provided so as to introduce water into the blender 18. An outlet 22 is provided so as to remove water from the blender 18. In order to allow for the intimate agglomeration between the particles of coal and the particles of hydrated lime to occur, the moisture content of the mixture must be maintained at an appropriate level. Accordingly, water is either added to or removed from the mixture in the blender 18 depending upon the moisture content of the coal. The moisture level of the resultant blended mixture should be within the range of between 10 and 30% on the basis of the overall weight. The preferred moisture level of the resultant mixture is approximately 25%. For example, the moisture content of the fresh coal may range from

a minimum of 15% to as high as 30% based upon the weight of the coal. If dried coal is used, then the moisture content may be as low as 1%. On the other hand, when the moisture content is below 10%, then it would be necessary to add water to the blender 18. As such, the inlet 20 and the outlet 22 are provided so as to add or remove water, respectively, as required relative to the moisture content of the coal.

The particles of hydrated lime  $[\text{Ca}(\text{OH})_2]$  distribute themselves among the coal particles through thorough mixing. However, because of their bonding characteristics, they adhere firmly to the coal particles. The average size of the resultant particles is 10 to 20% greater than that of the coal particles.

The agglomerated particles are then passed from the blender 18 to the dryer 24. In the dryer, the coal/hydrated lime mixture is dried so as to have a final moisture content of approximately 1%. The dryer 24 is an externally heated dryer or oven which acts on the coal/hydrated lime mixture with a temperature of between 300 and 400°F. The preferred temperature is 350°F. Any source of heat can be provided to the dryer 24 so as to accomplish the drying of the coal. For example, one source of heat for the drying can be surplus or waste heat from a power plant. The broken line 26 illustrates how this waste heat can be passed to the dryer 24 from the power plant. Another method of drying is to utilize the dryer 24 in a preheater with the same source of surplus or waste heat prior to the injection of the coal/hydrated lime mixture into the combustion chamber 28. By recirculating the heat from the combustion chamber or from the boiler of the power plant, a great deal of savings in the cost of energy and facilities for the drying of the coal/hydrated lime mixture can be achieved.



The following test results show the improvement in sulfur emission through the use of the process of the present invention:

A. Composition and Heating Value  
of the Original Sample  
(Illinois Coal: Sample No. 1 BC-110)

<u>Component</u>	<u>Wt%</u>
Moisture	10.6
Volatile Matter	39.5
Fixed C	50.8
H-T Ash	9.7
Carbon	71.3
Hydrogen	5.2
Nitrogen	1.4
Sulfatic Sulfur	0.1
Pyritic Sulfur	2.1
Organic Sulfur	2.4
Total Sulfur	4.6
Total Chlorine	0.0
High Heating Value (HHV) (Moisture Free Basis)	13,077 Btu/lb

B. Reduction in Sulfur Emission and  
High Heating Value (HHV)  
Treated Coal (SULFACOAL)

<u>Content of Reagent (wt%)</u>	<u>HHV, Moisture Free Basis (Btu/lb)</u>	<u>Estimated Reduction in Sulfur Emission (%)</u>
5	12094	ca. 80% or more
7	11896	ca. 85% or more

As can be seen from these test results, the process of the present invention treats high-sulfur coal with the fresh hydrated lime  $[\text{Ca}(\text{OH})_2]$  so that sulfur emission from the combustion of the coal can be reduced by up to 90%. Combustion of the treated coal generates less ash than that of untreated coal with sulfur-removal by a conventional lime (CaO) scrubbing system. The characteristics of the product of the process of the present invention are attributable to the fact that the fresh hydrated lime, yet to be exposed to carbon dioxide ( $\text{CO}_2$ ) in the atmosphere to any

appreciable extent, is far more reactive with sulfur in coal than unhydrated lime (CaO). Moreover, the ash of the treated coal of the process of the present invention has a lower pH than ash from conventional combustion and is of good quality. As a result, it makes the ash ideal for marketing rather than disposal.

The process of the present invention uses waste heat of the power plant and can be operated by current operators. Thus, these operators can maintain their own quality control on the fuel source with no change in coal supply or contractors. The process is not affected by extreme winter conditions and is suitable for direct feed to the boilers, thereby circumventing the necessity of preheating. By using waste heat, the process of the present invention conserves valuable resources and reduces the impact on the environment.

According to the test results utilizing the process of the present invention, the process of the present invention only marginally reduces the heating value or BTU's of the treated coal. However, the results indicate that emissions fall well below U.S. E.P.A. limits. Consequently, this decreases the requirement for expensive, sulfur-scrubbing equipment. Furthermore, a power plant supplied with the treated coal of the present invention requires much smaller amounts of scrubbing agents than an equivalent conventional power plant with sulfur scrubbing facilities. As a result, there is a savings on the costs of bulk handling, storage and transportation.

In addition to the substantial reduction in costs and in sulfur emissions, the treated coal of the present invention has two other noteworthy benefits. First, there is a decrease in NO<sub>x</sub> generation. Second, there is also a capture of heavy metals in the ash through the formation of metallic hydroxides with low solubilities. Moreover, the amount of ash from a power plant supplied with the treated coal of the present invention is an order of magnitude less than the amount of ash produced from an equivalent power plant utilizing lime injection.

The foregoing disclosure and description of the invention is illustrative and explanatory thereof. Various changes in the details of the illustrated process can be made within the scope of the present invention without departing from the true spirit of the invention.

CLAIMS

## WE CLAIM:

1. A method of manufacturing a coal product having reduced sulfur emissions comprising:  
grinding a raw coal material into a coal powder having a desired particle size;  
blending said coal powder with hydrated lime;  
adding water to the blend of coal powder and hydrated lime so as to have a moisture content of between 10 and 30 weight percent of the total weight of the water-added blend; and  
drying the water-added blend so as to have a desired moisture content.
2. The method of Claim 1, said coal powder having a particle size of between 80 and 20 meshes.
3. The method of Claim 2, said coal powder having an average particle size of 40 meshes.
4. The method of Claim 1, said raw coal material being a high-sulfur coal.
5. The method of Claim 1, said hydrated lime being of a particle form.
6. The method of Claim 5, said particle form of said hydrated lime having an average size of less than 10 percent of said desired particle size of said coal powder.

7. The method of Claim 1, said step of blending comprising:  
mixing said hydrated lime with said coal powder in which said hydrated lime is 1 to 15 weight percent of the weight of said coal powder.
8. The method of Claim 1, said step of adding water comprising:  
adding water to the blend so as to form an intimate agglomeration of said coal powder and said hydrated lime.
9. The method of Claim 1, said desired moisture content being less than 1 weight percent.
10. The method of Claim 1, said step of drying comprising:  
passing the water-added blend to an externally heated oven.
11. The method of Claim 10, said step of drying further comprising:  
heating the water-added blend to a temperature of between 300 and 400°F.
12. The method of Claim 11, said step of heating comprising:  
heating the water-added blend from waste heat from a power plant.
13. The method of Claim 10, said step of drying further comprising:  
preheating the water-added blend prior to passing the water-added blend into said externally heated oven.
14. The method of Claim 1, the raw coal material having a sulfur content of approximately 3% of a total weight of the raw coal material, said hydrated lime being between 5 to 6 weight percent of the total weight of the raw coal material.

15. A method of manufacturing a coal product having reduced sulfur emissions comprising:  
grinding coal into a powder having a particle size of between 80 and 20 meshes;  
blending the powder with hydrated lime in which the hydrated lime is between 1 to 15 weight percent of the weight of the powder;  
adding water to the blend so that the blend has a moisture content of between 10 and 30 weight percent of the total weight of the blend; and  
heating the water-added blend to a temperature of between 300 and 400°F  
so as to dry the blend to a moisture content of less than 1 weight percent.

15. The method of Claim 14, said coal having a sulfur content of no less than 3 weight percent of the total weight of the coal.

16. The method of Claim 14, said hydrated lime being between 5 to 6 weight percent of the total weight of the powder.

17. The method of Claim 15, said step of heating comprising:  
passing the blend to an externally heated oven.

18. The method of Claim 17, said step of heating further comprising:  
preheating the blend prior to passing the blend to said externally heated oven.

19. The method of Claim 15, said step of adding water comprising:  
intimately agglomerating the coal and the hydrated lime.

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization  
International Bureau

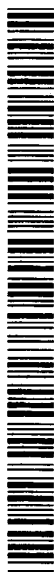


(43) International Publication Date  
12 April 2001 (12.04.2001)

PCT

(10) International Publication Number  
**WO 01/25373 A1**

- (51) International Patent Classification<sup>7</sup>: **C10L 9/10** Tseng [US/US]; 830 Lee Street, Manhattan, KS 66502 (US).
- (21) International Application Number: PCT/US00/27357
- (22) International Filing Date: 4 October 2000 (04.10.2000)
- (25) Filing Language: English
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- (30) Priority Data:  
60/157,657 5 October 1999 (05.10.1999) US
- (71) Applicants and  
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- (74) Agent: **EGBERT, John, S.**; Harrison & Egbert, Suite 100,  
1018 Preston Street, Houston, TX 77002 (US).
- (81) Designated States (*national*): CA, CN, JP, KR, US.
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CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC,  
NL, PT, SE).
- Published:**  
— With international search report
- For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.*



**WO 01/25373 A1**

(54) Title: PROCESS FOR MODIFYING COAL SO AS TO REDUCE SULFUR EMISSIONS

(57) Abstract: A method of manufacturing a coal product having reduced sulfur emissions including the steps of grinding coal into a powder form having a desired particle size; blending the ground coal with hydrated lime; adding water to the blend so as to have a moisture content of between 10 and 30 weight percent and drying the water-added blend so as to have a desired reduced moisture content. The desired reduced moisture content is less than 1 % of the total weight of the coal powder and the hydrated lime. The step of drying includes heating the water-added blend to a temperature of between 300 and 400 °F in an externally heated oven. Waste heat from a power plant can be used so as to heat the blend.

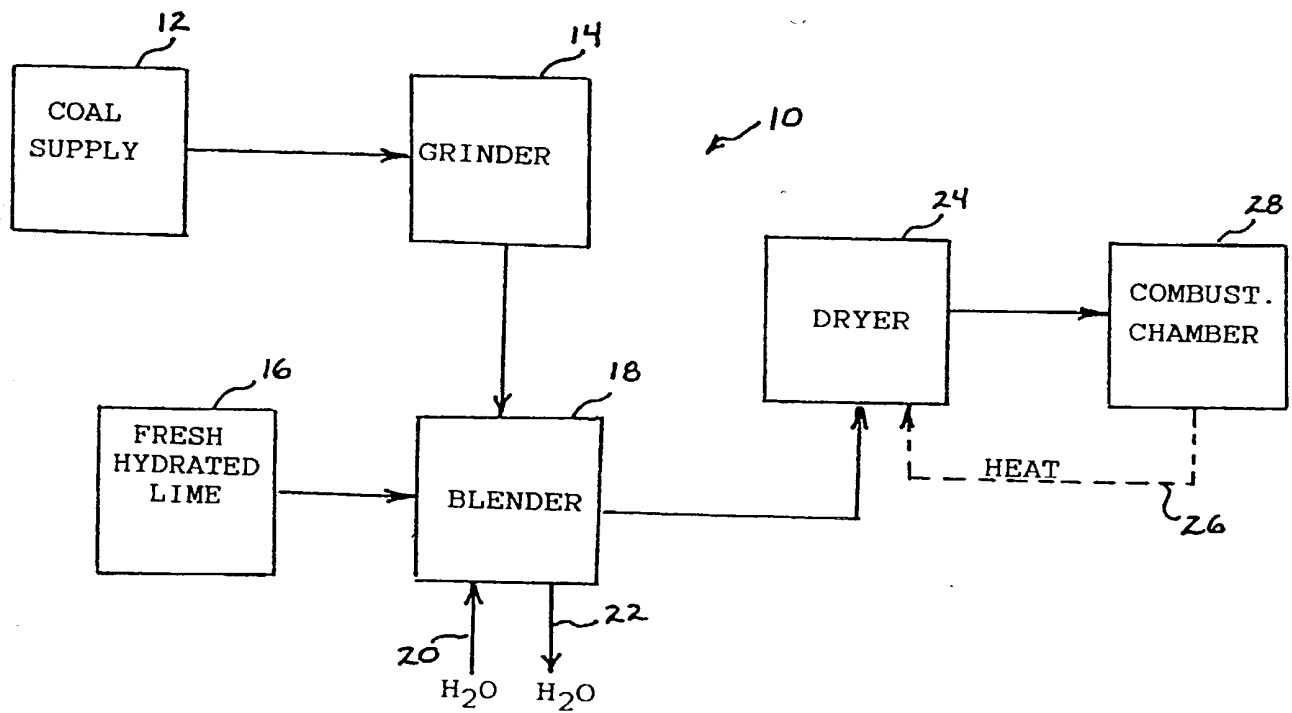


FIG. 1

656,096

Practitioner's Docket No. \_\_\_\_\_

**PATENT**

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**COMBINED DECLARATION AND POWER OF ATTORNEY**

(ORIGINAL, DESIGN, NATIONAL STAGE OF PCT, SUPPLEMENTAL, DIVISIONAL,  
CONTINUATION, OR C-I-P)

---

As a below named inventor, I hereby declare that:

**TYPE OF DECLARATION**

This declaration is of the following type:

(check one applicable item below)

☐ original.

☐ design.

*NOTE: With the exception of a supplemental oath or declaration submitted in a reissue, a supplemental oath or declaration is not treated as an amendment under 37 CFR 1.312 (Amendments after allowance). M.P.E.P. § 714.16, 7th Edition.*

☐ supplemental.

*NOTE: If the declaration is for an International Application being filed as a divisional, continuation or continuation-in-part application, do not check next item; check appropriate one of last three items.*

☒ national stage of PCT. (PCT/US00/27357)

*NOTE: If one of the following 3 items apply, then complete and also attach ADDED PAGES FOR DIVISIONAL, CONTINUATION OR C-I-P.*

*NOTE: See 37 C.F.R. § 1.63(d) (continued prosecution application) for use of a prior nonprovisional application declaration in the continuation or divisional application being filed on behalf of the same or fewer of the inventors named in the prior application.*

☐ divisional.

☐ continuation.

*NOTE: Where an application discloses and claims subject matter not disclosed in the prior application, or a continuation or divisional application names an inventor not named in the prior application, a continuation-in-part application must be filed under 37 C.F.R. § 1.53(b) (application filing requirements — nonprovisional application).*

☐ continuation-in-part (C-I-P).

**INVENTORSHIP IDENTIFICATION**

**WARNING:** *If the inventors are each not the inventors of all the claims, an explanation of the facts, including the ownership of all the claims at the time the last claimed invention was made, should be submitted.*

My residence, post office address and citizenship are as stated below, next to my name. I believe that I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter that is claimed, and for which a patent is sought on the invention entitled:

**TITLE OF INVENTION**

PROCESS FOR MODIFYING COAL SO AS TO REDUCE SULFUR EMISSIONS

---



## SPECIFICATION IDENTIFICATION

the specification of which:

(complete (a), (b), or (c))

(a) ☐ is attached hereto.

NOTE: "The following combinations of information supplied in an oath or declaration filed on the application filing date with a specification are acceptable as minimums for identifying a specification and compliance with any one of the items below will be accepted as complying with the identification requirement of 37 CFR 1.63:

"(1) name of inventor(s), and reference to an attached specification which is both attached to the oath or declaration at the time of execution and submitted with the oath or declaration on filing;

"(2) name of inventor(s), and attorney docket number which was on the specification as filed;  
or

"(3) name of inventor(s), and title which was on the specification as filed."

Notice of July 13, 1995 (1177 O.G. 60).

(b) ☐ was filed on \_\_\_\_\_, as ☐ Serial No. 0 / \_\_\_\_\_  
and was amended on \_\_\_\_\_ (if applicable).

NOTE: Amendments filed after the original papers are deposited with the PTO that contain new matter are not accorded a filing date by being referred to in the declaration. Accordingly, the amendments involved are those filed with the application papers or, in the case of a supplemental declaration, are those amendments claiming matter not encompassed in the original statement of invention or claims. See 37 C.F.R. § 1.67.

NOTE: "The following combinations of information supplied in an oath or declaration filed after the filing date are acceptable as minimums for identifying a specification and compliance with any one of the items below will be accepted as complying with the identification requirement of 37 CFR 1.63:

"(A) application number (consisting of the series code and the serial number, e.g., 08/123,456);

"(B) serial number and filing date;

"(C) attorney docket number which was on the specification as filed;

"(D) title which was on the specification as filed and reference to an attached specification which is both attached to the oath or declaration at the time of execution and submitted with the oath or declaration; or

"(E) title which was on the specification as filed and accompanied by a cover letter accurately identifying the application for which it was intended by either the application number (consisting of the series code and the serial number, e.g., 08/123,456), or serial number and filing date. Absent any statement(s) to the contrary, it will be presumed that the application filed in the PTO is the application which the inventor(s) executed by signing the oath or declaration."

M.P.E.P. § 601.01(a), 7th Ed.

(c) ☒ was described and claimed in PCT International Application No. PCT/US00/27357, filed on 4 Oct. 2000 and as amended under PCT Article 19 on Nov. 14, 2000 (if any).

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30

**SUPPLEMENTAL DECLARATION (37 C.F.R. § 1.67(b))**

*(complete the following where a supplemental declaration is being submitted)*

- ☐ I hereby declare that the subject matter of the
- ☐ attached amendment
- ☐ amendment filed on \_\_\_\_\_

was part of my/our invention and was invented before the filing date of the original application, above-identified, for such invention.

**ACKNOWLEDGEMENT OF REVIEW OF PAPERS AND DUTY OF CANDOR**

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information, which is material to patentability as defined in 37, Code of Federal Regulations, § 1.56,

*(also check the following items, if desired)*

- ☐ and which is material to the examination of this application, namely, information where there is a substantial likelihood that a reasonable Examiner would consider it important in deciding whether to allow the application to issue as a patent, and
- ☐ in compliance with this duty, there is attached an information disclosure statement, in accordance with 37 C.F.R. § 1.98.

**PRIORITY CLAIM (35 U.S.C. §§ 119(a)-(d))**

NOTE: "The claim to priority need be in no special form and may be made by the attorney or agent if the foreign application is referred to in the oath or declaration as required by § 1.63. The claim for priority and the certified copy of the foreign application specified in 35 U.S.C. 119(b) must be filed in the case of an interference (§ 1.630), when necessary to overcome the date of a reference relied upon by the examiner, when specifically required by the examiner, and in all other situations, before the patent is granted. If the claim for priority or the certified copy of the foreign application is filed after the date the issue fee is paid, it must be accompanied by a petition requesting entry and by the fee set forth in § 1.17(i). If the certified copy is not in the English language, a translation need not be filed except in the case of interference; or when necessary to overcome the date of a reference relied upon by the examiner; or when specifically required by the examiner, in which event an English language translation must be filed together with a statement that the translation of the certified copy is accurate." 37 C.F.R. § 1.55(a).

I hereby claim foreign priority benefits under Title 35, United States Code, §§ 119(a)-(d) of any foreign application(s) for patent or inventor's certificate or of any PCT international application(s) designating at least one country other than the United States of America listed below and have also identified below any foreign application(s) for patent or inventor's certificate or any PCT international application(s) designating at least one country other than the United States of America filed by me on the same subject matter having a filing date before that of the application(s) of which priority is claimed.

*(complete (d) or (e))*

- (d) ☐ no such applications have been filed.
- (e) ☒ such applications have been filed as follows.

NOTE: Where item (c) is entered above and the International Application which designated the U.S. itself claimed priority check item (e), enter the details below and make the priority claim.

(Declaration and Power of Attorney [1-1]—page 3 of 7)

**PRIOR FOREIGN/PCT APPLICATION(S) FILED WITHIN 12 MONTHS  
(6 MONTHS FOR DESIGN) PRIOR TO THIS APPLICATION  
AND ANY PRIORITY CLAIMS UNDER 35 U.S.C. § 119(a)-(d)**

COUNTRY (OR INDICATE IF PCT)	APPLICATION NUMBER	DATE OF FILING (day, month, year)	PRIORITY CLAIMED UNDER 37 USC 119
✓ PCT	PCT/US00/27357	4 Oct. 2000	<input type="checkbox"/> YES    NO <input type="checkbox"/> under PCT
			<input type="checkbox"/> YES    NO <input type="checkbox"/>
			<input type="checkbox"/> YES    NO <input type="checkbox"/>
			<input type="checkbox"/> YES    NO <input type="checkbox"/>
			<input type="checkbox"/> YES    NO <input type="checkbox"/>

**CLAIM FOR BENEFIT OF PRIOR U.S. PROVISIONAL APPLICATION(S)**  
(34 U.S.C. § 119(e))

I hereby claim the benefit under Title 35, United States Code, § 119(e) of any United States provisional application(s) listed below:

**PROVISIONAL APPLICATION NUMBER**

60 / 157,657  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

**FILING DATE**

5 Oct. 1999  
\_\_\_\_\_  
\_\_\_\_\_

**CLAIM FOR BENEFIT OF EARLIER US/PCT APPLICATION(S)  
UNDER 35 U.S.C. § 120**

- ☐ The claim for the benefit of any such applications are set forth in the attached ADDED PAGES TO COMBINED DECLARATION AND POWER OF ATTORNEY FOR DIVISIONAL, CONTINUATION OR CONTINUATION-IN-PART (C-I-P) APPLICATION.

**ALL FOREIGN APPLICATION(S), IF ANY, FILED MORE THAN 12 MONTHS  
(6 MONTHS FOR DESIGN) PRIOR TO THIS U.S. APPLICATION**

NOTE: If the application filed more than 12 months from the filing date of this application is a PCT filing forming the basis for this application entering the United States as (1) the national stage, or (2) a continuation, divisional, or continuation-in-part, then also complete ADDED PAGES TO COMBINED DECLARATION AND POWER OF ATTORNEY FOR DIVISIONAL, CONTINUATION OR C-I-P APPLICATION for benefit of the prior U.S. or PCT application(s) under 35 U.S.C. § 120.

**POWER OF ATTORNEY**

I hereby appoint the following practitioner(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith.

(list name and registration number)

Customer No. 24106

John S. Egbert; 30,627

Andrew W. Chu; 46,625

Al Harrison; 31,708



**24106**

PATENT & TRADEMARK OFFICE

(check the following item, if applicable)

- ☒ I hereby appoint the practitioner(s) associated with the Customer Number provided below to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith.
- ☐ Attached, as part of this declaration and power of attorney, is the authorization of the above-named practitioner(s) to accept and follow instructions from my representative(s).

NOTE: "Special care should be taken in continuation or divisional applications to ensure that any change of correspondence address in a prior application is reflected in the continuation or divisional application. For example, where a copy of the oath or declaration from the prior application is submitted for a continuation or divisional application filed under 37 CFR 1.53(b) and the copy of the oath or declaration from the prior application designates an old correspondence address, the Office may not recognize, in the continuation or divisional application, the change of correspondence address made during the prosecution of the prior application. Applicant is required to identify the change of correspondence address in the continuation or divisional application to ensure that communications from the Office are mailed to the current correspondence address. 37 CFR 1.63(d)(4)." § 601.03, M.P.E.P., 7th Edition.

**SEND CORRESPONDENCE TO**

☐ Address  
Harrison & Egbert  
412 Main Street, 7th Floor  
Houston, Texas 77002

☒ Customer Number 24106

**DIRECT TELEPHONE CALLS TO:**

(Name and telephone number)

John S. Egbert;  
713-224-8080

(complete the following if applicable)

Since this filing is a ☐ continuation ☐ divisional there is attached hereto a Change of Correspondence Address so that there will be no question as to where the PTO should direct all correspondence.

## DECLARATION

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

## SIGNATURE(S)

NOTE: Carefully indicate the family (or last) name, as it should appear on the filing receipt and all other documents.

NOTE: Each inventor must be identified by full name, including the family name, and at least one given name without abbreviation together with any other given name or initial, and by his/her residence, post office address and country of citizenship. 37 CFR § 1.63(a)(3).

NOTE: Inventors may execute separate declarations/oaths provided each declaration/oath sets forth all the inventors. Section 1.63(a)(3) requires that a declaration/oath, inter alia, identify each inventor and prohibits the execution of separate declarations/oaths which each sets forth only the name of the executing inventor. 62 Fed. Reg. 53,131, 53,142, October 10, 1997,

### Full name of sole or first inventor

1-00  
Robin B. SOMERVILLE  
(GIVEN NAME) (MIDDLE INITIAL OR NAME) FAMILY (OR LAST NAME)  
Inventor's signature [Signature]  
Date 6th APRIL 2002 Country of Citizenship USA ENGLAND  
Residence Port Neches, Texas TX  
Post Office Address 2517 Ninth Street  
Port Neches, Texas 77651 USA

### Full name of second joint inventor, if any

Liang-Tseng  FAN  
(GIVEN NAME) (MIDDLE INITIAL OR NAME) FAMILY (OR LAST NAME)  
Inventor's signature \*co-inventor signature on next page  
Date  Country of Citizenship USA  
Residence Manhattan, Kansas  
Post Office Address 830 Lee Street  
Manhattan, Kansas 66502 USA

### Full name of third joint inventor, if any

(GIVEN NAME) (MIDDLE INITIAL OR NAME) FAMILY (OR LAST NAME)  
Inventor's signature   
Date  Country of Citizenship   
Residence   
Post Office Address

## DECLARATION

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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NOTE: Inventors may execute separate declarations/oaths provided each declaration/oath sets forth all the inventors. Section 1.63(a)(3) requires that a declaration/oath, inter alia, identify each inventor and prohibits the execution of separate declarations/oaths which each sets forth only the name of the executing inventor. 62 Fed. Reg. 53,131, 53,142, October 10, 1997.

### Full name of sole or first inventor

Robin B. SOMERVILLE  
(GIVEN NAME) (MIDDLE INITIAL OR NAME) FAMILY (OR LAST NAME)  
Inventor's signature \*co-inventor signature on previous page  
Date \_\_\_\_\_ Country of Citizenship USA  
Residence Port Neches, Texas  
Post Office Address 2517 Ninth Street  
Port Neches, Texas 77651 USA

### Full name of second joint inventor, if any

200  
Liang-Tseng FAN  
(GIVEN NAME) (MIDDLE INITIAL OR NAME) FAMILY (OR LAST NAME)  
Inventor's signature Liang-Tseng Fan  
Date 4/10/2002 Country of Citizenship USA  
Residence Manhattan, Kansas KS  
Post Office Address 830 Lee Street  
Manhattan, Kansas 66502 USA

### Full name of third joint inventor, if any

(GIVEN NAME) (MIDDLE INITIAL OR NAME) FAMILY (OR LAST NAME)  
Inventor's signature \_\_\_\_\_  
Date \_\_\_\_\_ Country of Citizenship \_\_\_\_\_  
Residence \_\_\_\_\_  
Post Office Address \_\_\_\_\_

(check proper box(es) for any of the following added page(s)  
that form a part of this declaration)

- ☐ **Signature** for fourth and subsequent joint inventors. *Number of pages added* \_\_\_\_\_

\* \* \*

- ☐ **Signature** by administrator(trix), executor(trix) or legal representative for deceased or incapacitated inventor. *Number of pages added* \_\_\_\_\_

\* \* \*

- ☐ **Signature** for inventor who refuses to sign or cannot be reached by person authorized under 37 CFR 1.47. *Number of pages added* \_\_\_\_\_

\* \* \*

- ☐ Added page for **signature** by one joint inventor on behalf of deceased inventor(s) where legal representative cannot be appointed in time. (37 CFR 1.47)

\* \* \*

- ☐ Added pages to combined declaration and power of attorney for divisional, continuation, or continuation-in-part (C-I-P) application.

☐ Number of pages added \_\_\_\_\_

\* \* \*

- ☐ Authorization of practitioner(s) to accept and follow instructions from representative.

\* \* \*

(if no further pages form a part of this Declaration,  
then end this Declaration with this page and check the following item)

- ☒ **This declaration ends with this page.**